Electronics
Simple voltage dividers

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Wilfrid Laurier University

October 1, 2012

Applications of Kirchhoff's Voltage Law

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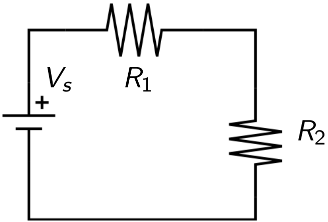
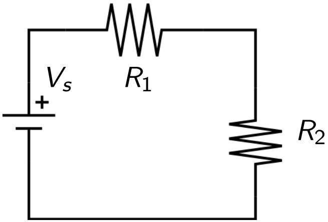
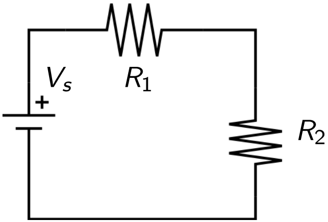
Voltage dividers

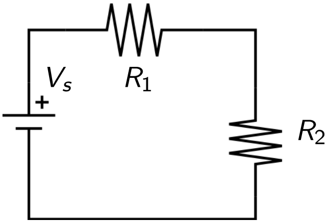

V_s
+
R_1
R_2



$$V_s = V_{R_1} + V_{R_2}$$



- A **voltage divider** “divides” the supply voltage



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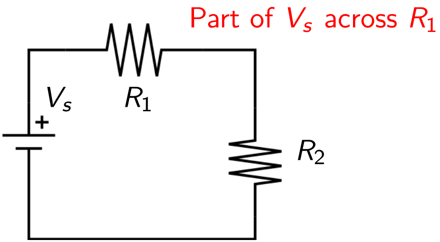
- It’s useful when you need a different voltage than the supply



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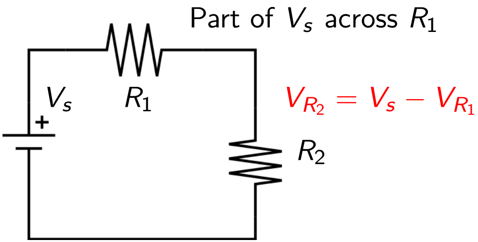

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Since the current is the same in both resistors, the voltage is *divided* between the two; thus it is a **voltage divider**.

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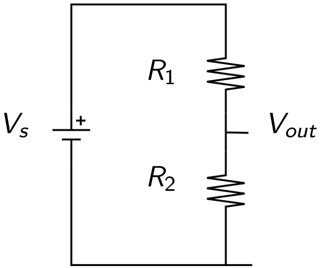
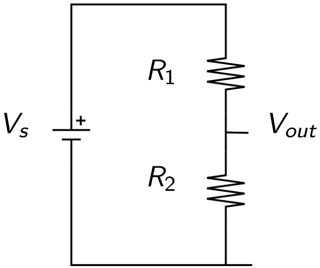
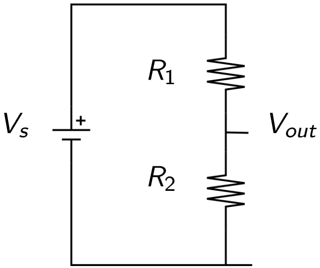

R_1
V_s
+
V_{out}
R_2



Usually a voltage divider is drawn like this so it looks like a ladder.



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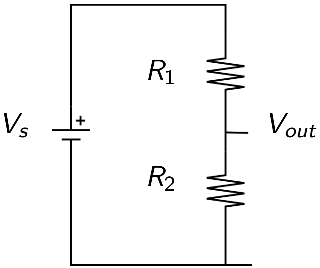
As you climb the ladder, the voltage increases.



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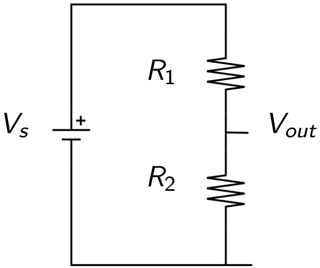
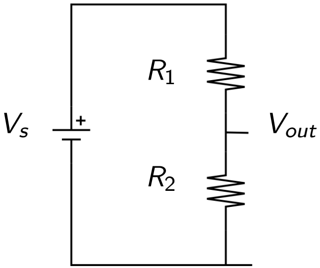
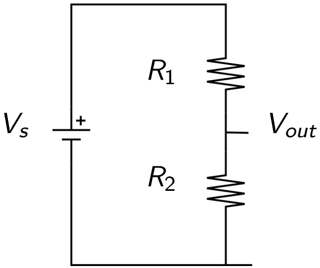


Since $I_1 = I_2$, (by Kirchhoff's current law,)



Since $I_1 = I_2$, (by Kirchhoff's current law),

and $V_s = V_{R_1} + V_{R_2}$,



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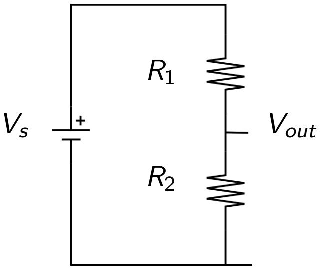

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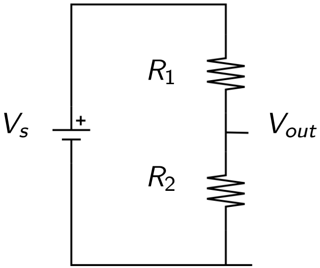

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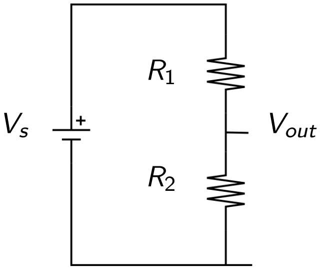

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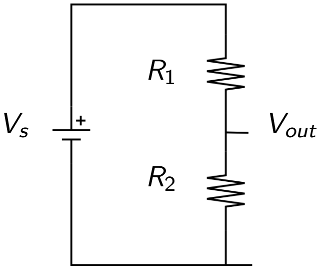
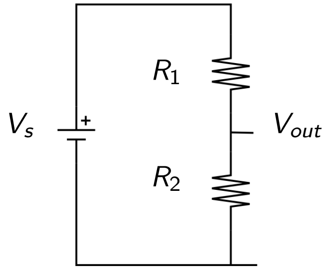
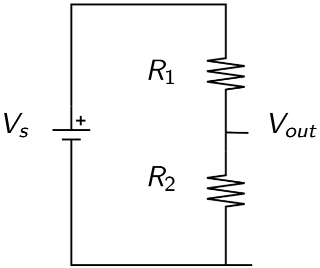
$I = \frac{V_s}{R_1+R_2}$



So $V_{out} = V_2 = IR_2$

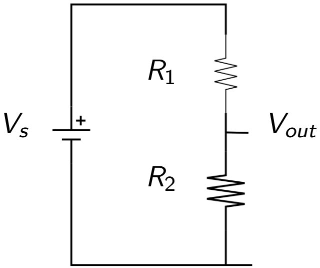


So $V_{out} = V_2 = IR_2 = \frac{V_s}{R_1+R_2} R_2$



So $V_{out} = V_2 = IR_2 = \frac{V_s}{R_1+R_2}R_2$

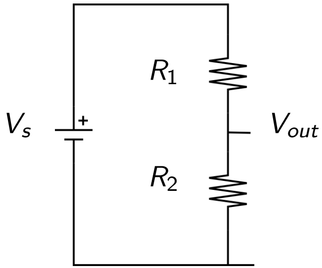
$= V_s\left(\frac{R_2}{R_1+R_2}\right)$



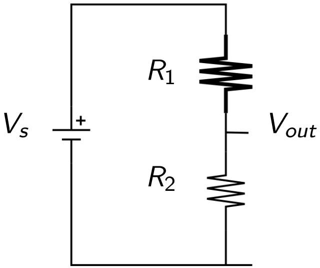
If R_1 gets *smaller*, then

$V_{out} = V_s \left(\frac{R_2}{R_1 + R_2} \right)$

gets *bigger*.



$$V_{out} = V_s \left(\frac{R_2}{R_1 + R_2} \right)$$



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Voltage divider (no load)

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V_{out}

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$$V_{out} = V_s\left(\frac{R_2}{R_1+R_2}\right) = 5\left(\frac{10}{5+10}\right)$$

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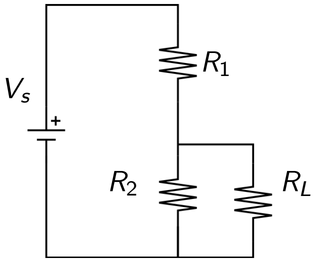
$$= V_s \left(\frac{R_2}{R_1 + R_2} \right) = 5 \left(\frac{10}{5+10} \right)$$

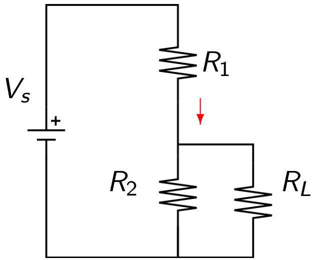
$$= 3.3V$$

Voltage divider (with load RL)

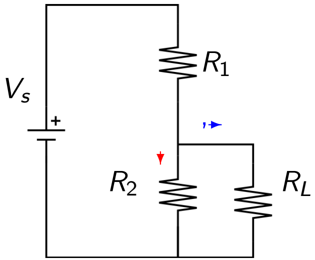


Load will reduce the output voltage

Voltage divider (with load RL)



Voltage divider (with load RL)



Some current goes through R_2, but some goes through R_L so the *effective* value of R_2 is reduced.

If $R_1 = 5\Omega$, $R_2 = 10\Omega$, $V_s = 5V$ and $R_L = 10\Omega$

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Thus V_{out}

$= V_s \frac{R_p}{R_1 + R_p} = 5\left(\frac{5}{5+5}\right)$

$= 2.5V$

Variable resistors

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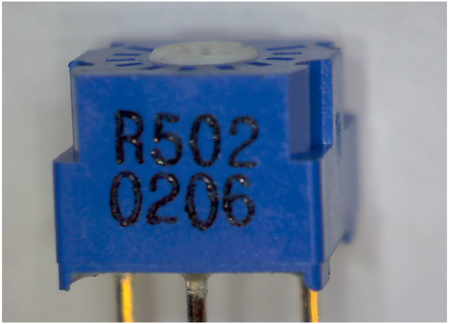
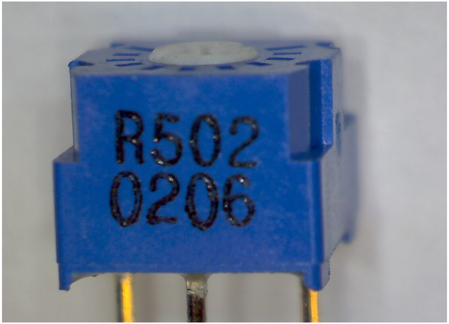
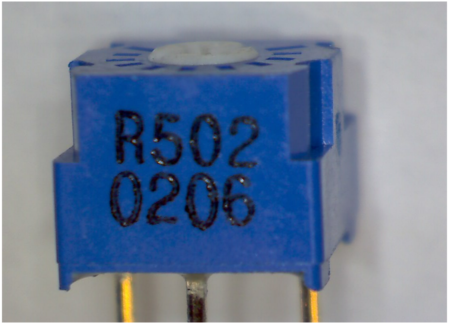
These are sometimes called **potentiometers** or **trimmers**.


R502
0206



Here is a trimmer.



Here is a trimmer. The top line should look familiar.

The potentiometer has three pins.

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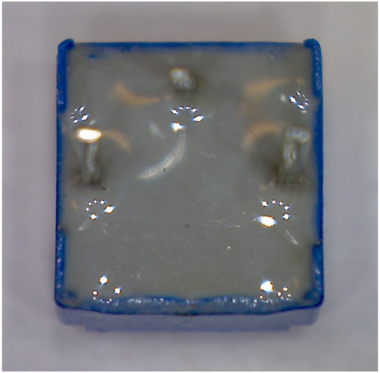
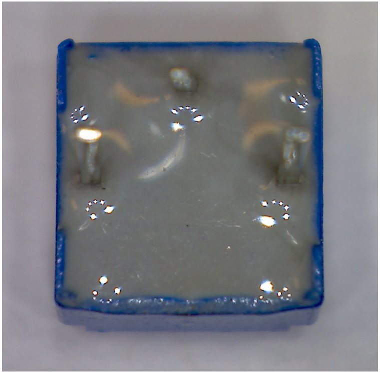
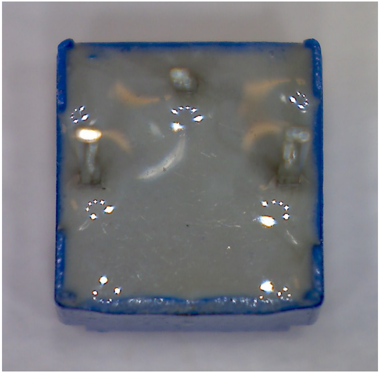
The resistance between the two end pins will be constant.

If you want a resistance which varies, just use the wiper and one end pin.

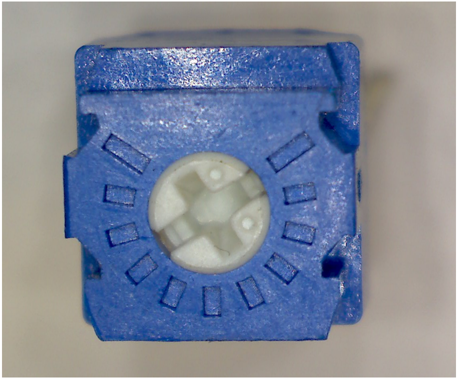


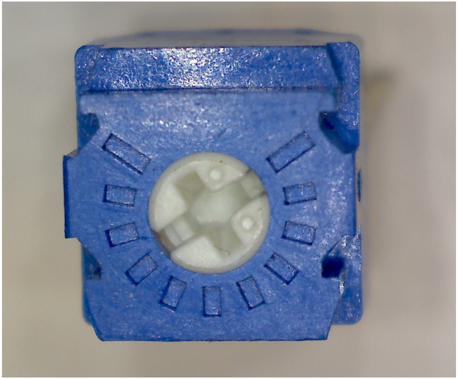


Here's a different view.

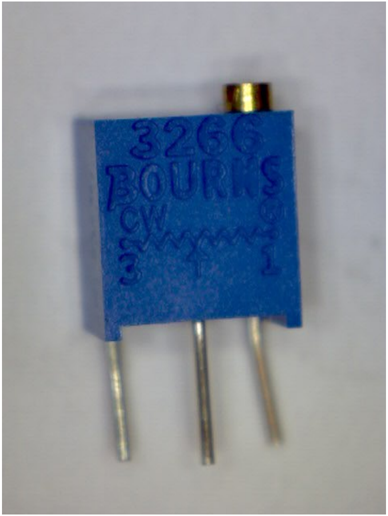


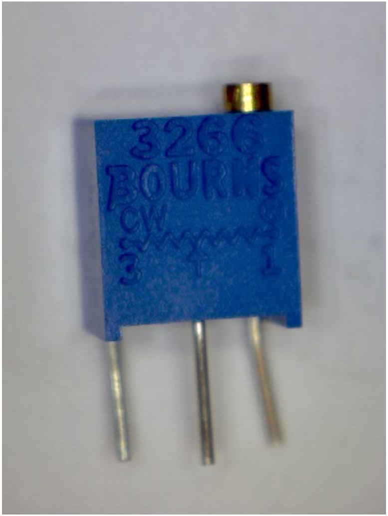
Here's a different view. The wiper is in the middle.





From the top, this one has 10 dashes to represent intervals of roughly $R/10$.


3266
BOURNS
CW
3
1



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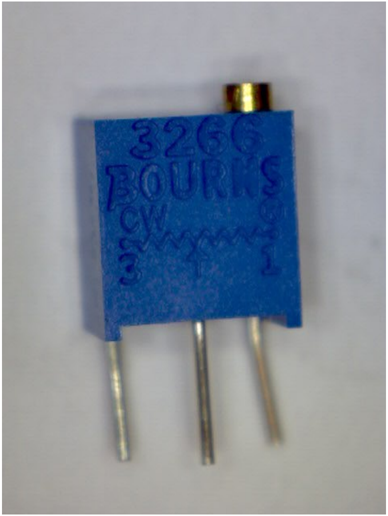

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Measure the output voltage on the wiper.

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Adjusting the wiper will change the output voltage from one end of the supply to the other, or to anywhere in between.